Claims

[c1] 1. A module oil seal assembly for use in an optical fiber hydrophone module, the module comprising an optical hydrophone assembly, a woven fiber protection cable assembly proximate to an end of the hydrophone assembly, an intermodule bulkhead coupling, and a clevis mounted to the intermodule bulkhead coupling, the hydrophone assembly comprising a plurality of mandrels helically wrapped with optical fiber and connected in linear relation, the woven fiber protection cable assembly comprising an elastic woven strap with one looped end, the looped end of the woven fiber protection cable assembly disposed at least partially within the clevis and towards the bulkhead coupling, the module oil seal assembly comprising:

a module oil seal, having a cylindrical wall with one end substantially closed and the other end open, the wall defining a cavity, the open end having an annular face plate extending outwardly from the periphery of the wall, the face plate surface distal from the closed end of the module oil seal being a face seal;

one orifice through the substantially closed end of the module oil seal, the orifice adapted to receive a check valve;

an opening through the substantially closed end for receiving optical fibers;

means for sealing in proximate registration with the face seal; and

wherein the module oil seal except for the face plate is reciprocally mounted within the clevis, and the face plate is reciprocally mounted within the bulkhead coupling such that the face seal abuts an adjacent surface of the coupling to make a seal.

[c2] 2. A module oil seal assembly as recited in claim 1, further comprising a retractable coiled tube housed within the cavity, adapted to receive optical fibers from the opening through the substantially closed end of the module oil seal.

[c3] 3. A module oil seal assembly as recited in claim 1, wherein the means for sealing comprises an O-ring.

[c4] 4. A module oil seal assembly as recited in claim 3, wherein the connection between the clevis and the bulkhead coupling compresses the O-ring seal and mechanically restrains the module oil seal.

[c5] 5. A module oil seal assembly as recited in claim 1, wherein the substantially closed end of the module oil seal is fastened to the looped end of the woven fiber protection cable assembly.

[c6] 6. A module oil seal assembly as recited in claim 1, wherein the orifice adapted to receive a check valve is centrally located in the substantially closed end of the module oil seal.

[c7] 7. A module oil seal assembly as recited in claim 1, further comprising a check valve disposed in the central orifice for filling and emptying the module with the module fill fluid.

[c8] 8. An optical fiber seal assembly for sealing between a cylindrical opening and one or more optical fibers passing therethrough, and for use in an optical fiber hydrophone module, the module comprising an optical hydrophone assembly, a woven fiber protection cable assembly

proximate to an end of the hydrophone assembly, a clevis, a module oil seal, and a clevis mounted to the intermodule bulkhead coupling, the hydrophone assembly comprising a plurality of mandrels helically wrapped with optical fiber and connected in linear relation, the woven fiber protection cable assembly comprising an elastic woven strap, the module oil seal having a substantially cylindrical wall that defines a cavity with one end open and the other end closed with at least one generally cylindrical opening through the substantially closed end for receiving optical fibers, the fiber seal assembly comprising:

a fiber seal adapted to be received in the module oil seal opening, the fiber seal having a substantially cylindrical wall defining a void for receiving bare optical fibers, the fiber seal having a first end and a second end, the first end disposed within the module oil seal, and having an O-ring around its periphery for forming a seal with the module oil seal opening;

potting compound within the fiber seal, for sealing between the optical fibers and the wall of the fiber seal;

a fiber seal retainer, having a first end and a second end, the first end being threaded into the module oil seal opening over the fiber seal;

a tube containing the optical fibers extending from the woven fiber protection cable assembly to the fiber seal retainer;

a compressive tube stop, having a substantially cylindrical wall defining a void adapted to receive the optical fiber tube, the tube stop having a first end and a second end, the tube stop first end reciprocally received in the fiber seal retainer second end, the tube stop first end having at least one slot across its first end diameter for allowing compression of the tube

stop first end within the fiber seal retainer second end to a snug fit; and a retainer cap having a substantially cylindrical wall with one end open and the other end substantially closed, with at least one orifice through the substantially closed end for receiving optical fibers, the retainer cap open end being threaded over the fiber seal retainer second end.

[c9] 9. A module oil seal assembly for use in an optical fiber hydrophone module, the module comprising an optical hydrophone assembly, a woven fiber protection cable assembly proximate to an end of the hydrophone assembly, and a clevis mounted to the intermodule bulkhead coupling, the hydrophone assembly comprising a plurality of mandrels helically wrapped with optical fiber and connected in linear relation, the woven fiber protection cable assembly comprising an elastic woven strap with one looped end, the looped end of the woven fiber protection cable assembly disposed at least partially within the clevis and towards the bulkhead coupling, the module oil seal assembly comprising:
a module oil seal, having a cylindrical wall with one end substantially closed and the other end open, the wall defining a cavity, the open end having an annular face plate extending outwardly from the periphery of the wall, the face plate surface distal from the closed end of the module oil seal being a face seal;
one orifice through the substantially closed end of the module oil seal, the orifice adapted to receive a check valve;
an opening through the substantially closed end for receiving optical fibers;
an O-ring in proximate registration with the face seal;
a fiber seal adapted to be received in the module oil seal opening, the

fiber seal having a substantially cylindrical wall defining a void for receiving bare optical fibers, the fiber seal having a first end and a second end, the first end disposed within the module oil seal, and having an O-ring around its periphery for forming a seal with the module oil seal opening;

potting compound within the fiber seal, for sealing between the optical fibers and the wall of the fiber seal;

a fiber seal retainer, having a first end and a second end, the first end being threaded into the module oil seal opening over the fiber seal;

a tube containing the optical fibers extending from the woven fiber protection cable assembly to the fiber seal retainer;

a compressive tube stop, having a substantially cylindrical wall defining a void adapted to receive the optical fiber tube, the tube stop having a first end and a second end, the tube stop first end reciprocally received in the fiber seal retainer second end, the tube stop first end having at least one slot across its first end diameter for allowing compression of the tube stop first end within the fiber seal retainer second end to a snug fit; and

a retainer cap having a substantially cylindrical wall with one end open and the other end substantially closed, with at least one orifice through the substantially closed end for receiving optical fibers, the retainer cap open end being threaded over the fiber seal retainer second end.

wherein the module oil seal except for the face plate is reciprocally mounted within the clevis, and the face plate is reciprocally mounted within the bulkhead coupling such that the face seal abuts an adjacent surface of the coupling to make a seal.

[c10] 10. A module oil seal assembly as recited in claim 9, further comprising a

retractable coiled tube housed within the cavity of the module oil seal, adapted to receive optical fibers from the opening through the substantially closed end of the module oil seal.

[c11] 11. A module oil seal assembly as recited in claim 9, wherein the connection between the clevis and the bulkhead coupling compresses the O-ring seal and mechanically restrains the module oil seal.

[c12] 12. A module oil seal assembly as recited in claim 9, wherein the substantially closed end of the module oil seal is fastened to the looped end of the woven fiber protection cable assembly.

[c13] 13. A module oil seal assembly as recited in claim 9, wherein the orifice adapted to receive a check valve is centrally located in the substantially closed end of the module oil seal.

[c14] 14. A module oil seal assembly as recited in claim 13, further comprising a check valve disposed in the central orifice for filling and emptying the module with the module fill fluid.

[c15] 15. An optical fiber hydrophone module comprising:
an optical hydrophone assembly comprising a plurality of mandrels helically wrapped with optical fiber and connected in linear relation;
a woven fiber protection cable assembly proximate to an end of the hydrophone assembly and comprising an elastic woven strap with one looped end, the looped end of the woven fiber protection cable assembly disposed at least partially within the clevis towards the bulkhead coupling
an intermodule bulkhead coupling at the end of the module;

a clevis mounted to the intermodule bulkhead coupling;

a module oil seal, having a cylindrical wall with one end substantially closed and the other end open, the wall defining a cavity, the open end having an annular face plate extending outwardly from the periphery of the wall, the face plate surface distal from the closed end of the module oil seal being a face seal;

one orifice through the substantially closed end of the module oil seal, the orifice adapted to receive a check valve;

an opening through the substantially closed end for receiving optical fibers; and

an O-ring in proximate registration with the face seal,

wherein the module oil seal except for the face plate is reciprocally mounted within the clevis, and the face plate is reciprocally mounted within the bulkhead coupling such that the face seal abuts an adjacent surface of the coupling to make a seal.

[c16] 16. An optical fiber hydrophone module comprising:

an optical hydrophone assembly comprising a plurality of mandrels helically wrapped with optical fiber and connected in linear relation;

a woven fiber protection cable assembly proximate to an end of the hydrophone assembly and comprising an elastic woven strap;

an intermodule bulkhead coupling at the end of the module;

a clevis mounted to the intermodule bulkhead coupling;

a module oil seal having a substantially cylindrical wall that defines a cavity with one end open and the other end closed with at least one generally cylindrical opening through the substantially closed end for receiving optical fibers;

a fiber seal disposed in the module oil seal opening, the fiber seal having a substantially cylindrical wall defining a void for receiving bare optical fibers, the fiber seal having a first end and a second end, the first end disposed within the module oil seal, and having an O-ring around its periphery for forming a seal with the module oil seal opening;

potting compound within the fiber seal, for sealing between the optical fibers and the wall of the fiber seal;

a fiber seal retainer, having a first end and a second end, the first end being threaded into the module oil seal opening over the fiber seal;

a tube containing the optical fibers extending from the woven fiber protection cable assembly to the fiber seal retainer;

a compressive tube stop, having a substantially cylindrical wall defining a void adapted to receive the optical fiber tube, the tube stop having a first end and a second end, the tube stop first end reciprocally received in the fiber seal retainer second end, the tube stop first end having at least one slot across its first end diameter for allowing compression of the tube stop first end within the fiber seal retainer second end to a snug fit; and

a retainer cap having a substantially cylindrical wall with one end open and the other end substantially closed, with at least one orifice through the substantially closed end for receiving optical fibers, the retainer cap open end being threaded over the fiber seal retainer second end.

[c17] 17. A method of assembling a termination assembly for use in an optical fiber hydrophone module, the module comprising an optical hydrophone assembly, a woven fiber protection cable assembly proximate to an end of the hydrophone assembly, an intermodule bulkhead coupling at an end of the hydrophone module, and a clevis mounted to the intermodule

bulkhead coupling, the hydrophone assembly comprising a plurality of mandrels helically wrapped with optical fiber and connected in linear relation, the woven fiber protection cable assembly comprising an elastic woven strap with one looped end, the looped end of the woven fiber protection cable assembly disposed at least partially within the clevis and towards the bulkhead coupling, the method comprising the steps of:

providing a module oil seal, the module oil seal having a cylindrical wall with one end substantially closed and the other end open, the wall defining a cavity, the open end having an annular face plate extending outwardly from the periphery of the wall, the face plate surface distal from the closed end of the module oil seal being a face seal;

inserting the module oil seal substantially closed end into the clevis whereby the module oil seal except for the face plate is reciprocally mounted within the clevis, and;

providing an O-ring in proximate registration with the face seal; and

mounting the intermodule bulkhead coupling to the clevis, whereby the face plate is reciprocally mounted within the bulkhead coupling, compressing the O-ring to make a seal between the intermodule mechanical coupling and the clevis.

[c18] 18. A method of assembling a termination assembly as recited in claim 17, further comprising the steps of:

providing one orifice through the substantially closed end of the module oil seal, the orifice adapted to receive a check valve; and

inserting a check valve in the orifice.

[c19] 19. A method of assembling a termination assembly as recited in claim

18, further comprising the steps of:

providing an opening through the substantially closed end of the module oil seal for receiving optical fibers;

providing a retractable coiled tube housed within the cavity, adapted to receive optical fibers from the opening through the substantially closed end of the module oil seal.

[c20] 20.A method of assembling a termination assembly as recited in claim 19, further comprising the step of fastening the substantially closed end of the module oil seal to the looped end of the woven fiber protection cable assembly.

[c21] 21.A method of assembling a termination assembly as recited in claim 20, further comprising the step of filling the module with the module fill fluid through the check valve.

[c22] 22.A method of assembling a termination assembly as recited in claim 21, further comprising the steps of:

inserting a fiber seal adapted to be received in the module oil seal opening, the fiber seal having a substantially cylindrical wall defining a void for receiving bare optical fibers, the fiber seal having a first end and a second end, the first end disposed within the module oil seal, and having an O-ring around its periphery for forming a seal with the module oil seal opening;

packing the void in the fiber seal with potting compound, for sealing between the optical fibers and the wall of the fiber seal;

threading a fiber seal retainer, having a first threaded end and a second

end, into the module oil seal opening over the fiber seal;

extending a tube containing the optical fibers from the woven fiber protection cable assembly to the fiber seal retainer;

reciprocally mounting a compressive tube stop to the fiber seal retainer second end, the compressive tube stop having a substantially cylindrical wall defining a void adapted to receive the optical fiber tube, the tube stop having a first end and a second end, the tube stop first end having at least one slot across its first end diameter for allowing compression of the tube stop first end within the fiber seal retainer second end to a snug fit; and

mounting a retainer cap having a substantially cylindrical wall with one threaded end open and the other end substantially closed, with at least one orifice through the substantially closed end for receiving optical fibers, to the fiber seal retainer second end.